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**Systems Requirements Document**  
**For**  
**Circuit Switched Data**

**Release D.00.00.01**

**May 20, 1998**

**TTY Forum**

# Circuit Switched Data and IWF Technical Requirements Document

## Revision History

Rev	Doc ID	Date	Author	Description
1	D 00.00.00	5/15/98	B.B.	initial version reviewed by CTIA
2	D 00.00.01	5/20/98	B.B.	distribution to TTY Forum for comments
3				
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### D00.00.00 numbering scheme instructions -

- 1) D 00.00.00 to D.00.00.99 is used for initial draft versions
- 2) D 01.00.00 is used for the first version
- 3) D 01.00.01 to D01.00.99 is used for minor changes on version D 01
- 4) D 02.00.00 is reserved for major changes (major sections of document revised, added, deleted)
- 5) D 02.00.01 to D02.00.99 is used for minor changes on version D 02
- 6) R.01.00.01 is the first released variant.

# **Circuit Switched Data and IWF Technical Requirements Document**

## **1. Acronyms and Definition of Terms**

BSC	Base Site Controller
CO	Central Office
CSD	Circuit Switched Data
DTE	Data Terminal Equipment
ERP	Effective Radiated Power
FRU	Field Replaceable Unit
IWF	Interworking Function
LAN	Local Area Network
MS	Mobile Station
MSC	Mobile Switching Station
MS	Mobile Station
MSO	Mobile Switching Office
PCM	Pulse Code Modulation
RLP	Radio link protocol
SRD	Systems Requirements Documents
SU	Subscriber Unit
TCH	Traffic Channel
TDD	Telecommunications Device for the Deaf

# **Circuit Switched Data and IWF Technical Requirements Document**

## **2. Introduction**

### **2.1 Purpose**

Circuit switched data (CSD) is a service which is complementary to the existing suite of Wireless Voice and Data services including telephone interconnect, Short Message Service (SMS) and Packet Data. CSD enables subscribers to directly connect a laptop or facsimile device to their Multi-Service portable for remote wireless modem and fax data communications to wireline data services.

The Inter-Working Function (IWF) platform contains the hardware and software elements required to facilitate CSD service through each carrier's Mobile Switching Center (MSC).

The purpose of this document is to define the requirements for circuit switched data (CSD) and the Inter-Working Function (IWF).

### **2.2 Scope**

This document attempts to define product feature and functional requirements for the Circuit Switched Data IWF across wireless infrastructures.

Circuit switched data is envisioned as a service that would be integrated onto wireless platforms to complement the existing suite of voice and data services.

Circuit switched data service enables a wide range of applications, and can be combined with Packet Data and SMS to fully meet deaf and hard of hearing data communication needs.

#### **2.2.1 Immediate Customer Requirement**

The wireless community's requirements for circuit switched data are driven by their interest in providing the capability for the deaf and hard of hearing community to use circuit switched data if they so desire. This will be accomplished by connecting the deaf and hard of hearing subscriber's computers via CSD. CSD service will also be made universally available to all subscribers with properly equipped and enabled subscriber units.

The development of the Circuit Switched Data IWF to meet the immediate Wireless Service Provider data requirements will also provide a universal IWF platform with the features and flexibility necessary to satisfy additional customers and markets.

### **2.3 Goals**

The goals satisfied by a product that meets the requirements of this document include:

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- Enabling effective circuit switched data for the deaf and hard of hearing community.
- Develop an IWF platform that provides the following benefits to customers :
  - allow customers the additional benefits of using CSD
  - increased number of T1/E1 channels per platform
  - flexible platform allowing easy feature addition and channel expansion with minimum hardware changes
  - IWF platform must be functionally backward compatible to the previously installed carrier base.

### **3. Customer and Service Provider Requirements**

The **customer functionality expectations** include:

- Enables asynchronous, non-transparent Facsimile and Data Services to a wireless network containing an MSC.
- No impact to existing subscribers.
- Supports Group 3 Fax Teleservice and a wide range of 300 - 33,600 bps modem data.

The **Service Provider expectations** include:

- 24/30 IWF T1/E1 data ports as a minimum configuration.
- Expandable in 24/30 IWF T1/E1 data port increments.
- Each IWF will contain a redundant -48Vdc internal power supply.

#### **3.1 Customer Statement**

Not Available

#### **3.2 Operational Scenarios for Circuit Switched Data**

##### **3.2.1 CSD System Overview:**

Circuit Switched Data (CSD) is a service which is complementary to the existing suite of Voice and Data services including telephone interconnect, Short Message Service (SMS) and Packet Data. CSD enables subscribers to directly connect a laptop or facsimile device to their Multi-

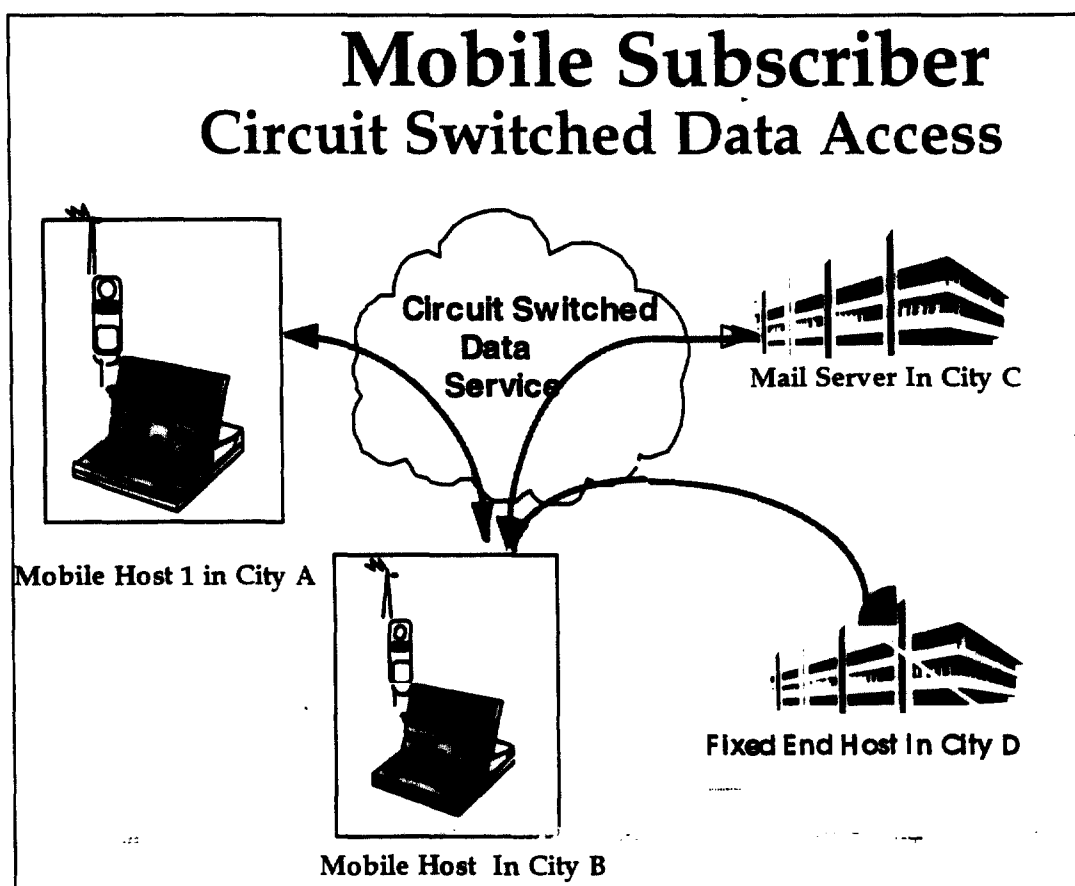
## Circuit Switched Data and IWF Technical Requirements Document

Service portable for remote wireless modem and fax data communications to wireline data services.

The Interworking Function (IWF) contains the hardware and software element that provides the rate adaptation and protocol conversion between a land destination Public Switched Telephone Network (PSTN) and the network for both data and fax services. The IWF is required at each Mobile Switching Center (MSC) to support circuit switched data.

### 3.2.2 User's Perspective

From the user's perspective, the circuit switched data system provides delivery of information to and between mobile subscribers. Circuit switch data subscribers can maintain access to information resources from anywhere in the nation where coverage is available.



After a user powers on their Mobile Station (MS) and TDD or specialized terminal equipment, the user initiates the circuit switched data session by dialing a remote TDD or FAX device. Once this step is completed, users may send and receive information to desired hosts and other mobile users as needed through standard applications. No additional "connection" action is required by the user other than what is required by the Fixed End Operating System for activating applications.

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### **3.2.3 Application Perspective**

In the context of the network, a mobile subscriber communicates through a mobile host. A **Mobile Host** is the combination of a Mobile Station and a Data Terminal Equipment (DTE). The Mobile Station is the user radio device that communicates with the infrastructure. Laptops and specialty terminals are referred to as DTE.

The Local Area Network (LAN) servers and hosts accessed through the Network are referred to as **Fixed End Hosts**.

The circuit switched data system provides information delivery by supporting TDD, fax and modem applications between Mobile Hosts and Fixed End Hosts or other Mobile Hosts.

#### **3.2.3.1 Fixed End Host Initiated Communications**

A customer's Fixed End Host, internetworked with the circuit switched data system, can send TDD transmissions, other modem transmissions, and facsimile to any Mobile Host within the coverage area that has its DTE powered on and has registered with the circuit data System. Fixed End Hosts are not aware of the Mobile Host's actual location and do not need any special software to support mobility.

#### **3.2.3.2 Mobile Host Initiated Communications**

A Mobile Host within the coverage area of the network can send TDD data, standard modem data, and Facsimile to any Fixed End Host internetworked with the circuit switched network.

A Mobile Host can appear to Fixed End Hosts as part of a LAN and have full access to existing LAN services available. This may include file server access, e-mail, and other applications supported by the Fixed End Host Operating System.

## **4. Assumptions and Observations**

During the time this SRD is constructed, reasonable assumptions are placed on the network, subscriber, and customer which are important to document. These assumptions convey the base or foundation upon which the SRD's requirements are created and defined. Some of these assumptions help portray the expected conditions at the time of feature deployment. More defined expected customer behaviors. Others define features that will not be impacted or supported by this feature (i.e. negative requirements). These assumptions, if not held true, would impact the SRD requirements, either by making them incorrect, insufficient or not workable.

### **4.1 Applicable Call Model**

The IWF Call Model is as follows:

- 180 sec hold time
- 0.005 Erlangs per IWF call
- 0.1 IWF Blocking Rate
- 0.1 Calling Rate



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### **4.1.1 Traffic Model**

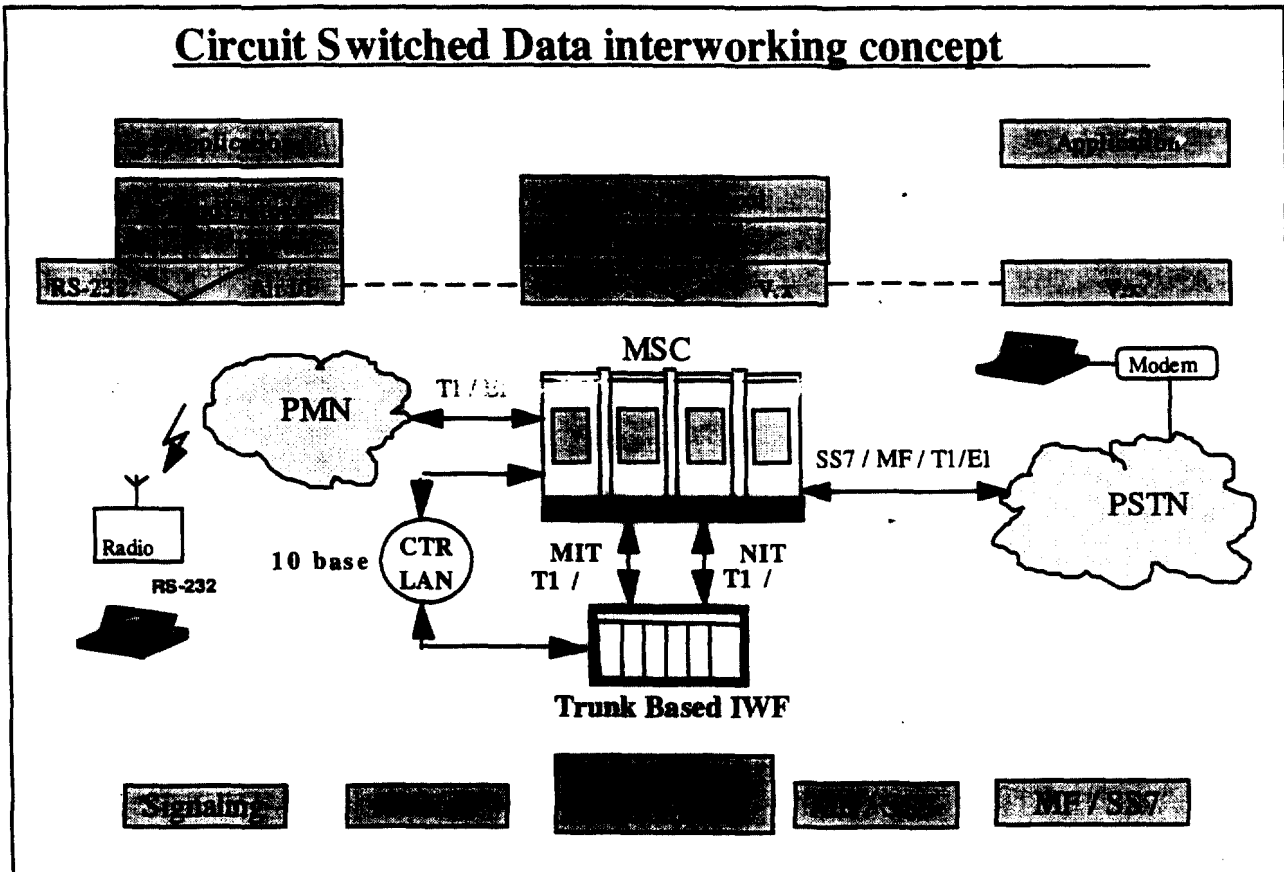
A 24 T1 port - IWF will support approximately 2,920 CSD subscribers based upon the Call Model above. If the user call pattern differ from the above model, fewer overall subscribers may be supported.

### **4.2 Approach**

Successful development of the IWF is the critical first step required to provide a multi-access platform that enables the addition of customer features and functions that are needed by the deaf and hard of hearing community. The approach is to employ an X.86 based platform that incorporates "off the shelf" hardware and software components to leverage commercial product cost curves and multi-vendor availability.

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The diagram below shows the network including the Circuit Switched Data elements.



The minimum elements required to be added to an network to implement CSD as shown above include:

- Trunk based IWF Unit - 24/30 T1/E1 ports minimum capability
- A Mobile Interface Trunk (T1/E1) and Network Interface Trunk (T1/E1)
- MSC/IWF Control 10BaseT ethernet LAN external interface equipment
- IWF software

The required infrastructure software modifications include:

- MS UNITS: Must be equipped and enabled for data
- Wireless Infrastructure: Must support CSD and air data interface framing.
- MSC: Requires new call setup elements including IWF control functionality, mobile termination number translation, and new billing fields for existing carrier billing systems.

## 5. Numbered Requirements

### 5.1 System Requirements

The following paragraphs describe the CSD IWF system requirements.

# **Circuit Switched Data and IWF Technical Requirements Document**

## **5.1.1 Function & Feature Requirements**

### **R1 Backward Compatible Functionally and Features**

The IWF will not impact existing subscribers.

### **R2 Supports TDD Service**

The IWF is required to enable TDD devices connected to a network containing an MSC.

### **R3 Supports Group 3 Fax**

The IWF at each Mobile Switching Center (MSC), is required to be capable of supporting Circuit Switched FAX with Group 3 compatibility.

### **R4 Supports Asynchronous Non-Transparent Modem Data Standards**

The IWF is required to support the following asynchronous non-transparent modem types: V.21, V.22, V.22bis, V.23, V.27ter, V.29 and V.32, V.32bis, V.33, V.34, Bell 212A, Bell 103 as well as V.42bis, data compression, V.42 and MNP level 2-5 error control, V.25bis autodialer, and V.54 loop backs. Data mode full duplex, synchronous and asynchronous, operation at 300, 1200, 2400, 4800, and 9600 Data Carrier Equipment (DCE) data rates must also be supported.

### **R5 Provides 24/30 T1/E1 MCS/IWF ports minimum capability**

The IWF should provide 24/30, T1/E1, ports for a minimum configuration.

### **R6 Expandable in 24/30 Port Increments - 48/60 ports per Chassis**

The IWF should be expandable in expectation of the future increase in circuit data usage.

### **R7 Redundant -48Vdc Power Supplies Within the IWF Chassis**

The IWF should contain internal redundant -48Vdc power supplies.

## **5.2 Network Management Requirements**

### **R8 Communications Frequency Band Compatibility:**

The IWF must be compatible with the RF system.

### **R9 MSC Compatibility Requirements:**

The IWF interfaces directly with the MSC only; therefore the MSC controls the insertion and removal of an IWF Element to and from the network path of a data call. The CSD IWF System requires new MSC call setup elements including IWF control functionality, mobile termination number translation, and new billing fields for existing carrier billing systems.

### **R10 Mobile Link Compatibility Requirements:**

The Mobile Link function must support the Radio Link Protocol (RLP) interworking

## **Circuit Switched Data and IWF Technical Requirements Document**

between a Mobile Station and the IWF to transport data over the air interface.

### **R11 Mobile Interface Trunk (MIT) Compatibility Requirements:**

The MSC connects to the Mobile-side Interworking function over a Mobile-side IWF Trunk. The MIT moves the digitally(RLP ) encoded subscriber data from the MSC to the IWF. The IWF/MSC MIT interface is required to be a standard T1, PCM 24 channel interface.

### **R12 Network Interface Trunk (NIT) Compatibility Requirements:**

The network-side function supports the protocol interworking between the IWF and a fixed network. The NIT moves the 64Kbps Pulse Code Modulation (PCM) digital representation of the subscriber/host fax/modem data to/from the PSTN . The IWF modems perform the PCM encoding/decoding and places the data into the appropriate DSO channel. The MSC connects to the Network-side Interworking function over a Network-side IWF Trunk. The IWF/MSC NIT interface must be a standard T1, PCM 24 channel interface.

## **5.3 Subscriber Provisioning Requirements**

The MS formats the data stream from the DTE for transmission over the radio interface. This involves a number of steps, depending on the speed and type of data supplied. The MS also performs the user side of the Radio Link Protocol (RLP) and forwards the data from the network to the connected DTE.

The system operator is responsible for configuring subscriber classes to permit IWF CSD functionality.

### **R13 Subscriber DTE interconnect Cable and Peripheral Requirements**

An adapter cable for the data-capable subscriber unit, and a personal computer is required.

### **5.3.1 Provisioning Requirements**

#### **R14 Subscriber Enabling**

Subscriber units must be equipped and enabled for data. This enabling is done through the service provider interface to the MSC-HLR..

### **5.3.2 Interaction with Existing or New Service Options**

#### **R15 SMS**

Short messages can be delivered to the mobile during circuit switched data. However, short message notification is not performed until after completion of the CSD call.

#### **R16 Interconnect voice**

## **Circuit Switched Data and IWF Technical Requirements Document**

Interconnect voice calls will not be delivered to the subscriber during CSD calls.

### **R17 Call Forwarding**

Call Forwarding for CSD must work the same as voice except that it can be provisioned separately from voice. (separate activation status and call forwarding number can be associated with each call forwarding type, separate from voice). Note data call forwarding activation/deactivation must be performed by the system operator; it cannot be done at the mobile as can voice call forwarding.

## **5.4 Mobility Requirements**

### **R18 Handoff**

A data call will utilize a traffic channel (TECH), like voice calls do, therefore the radio resource (RR) layer acts no differently. A handoff may result in a momentary loss of communication signal. During a non-transparent data call, radio link protocol error correction should be used between the MS and the IWF to help reduce the data loss by re-transmitting the lost packets.

## **5.5 Billing Requirements**

There are no new structured records or enhancements to the fixed part of the structured records for CSD. New modules added to MO and MT records include bearer, teleservices, and data service information. Additionally, the location and channel information module is enhanced.

# CDMA Solutions for TTY

Nikolai Leung

## Outline

- The voice-based approach
- The data-service approach
  - user requirements
  - description
  - challenges
- Policy Considerations

## Voice Services

- Wireless digital technologies provide improved voice quality with higher capacity (more users) using vocoders
- Digital voice services are specifically optimized for speech

## Problems with Voice-Based TTY

- Standard voice services can not transmit TTY data reliably
  - Character error rates of 8-12% for CDMA
  - Frame erasure rates for voice services result in poor TTY data performance
  - CDMA variable rate vocoder causes TTY signal distortion
  - Noise suppressors can attenuate TTY signal due to false noise detection

## Modifying Voice Services for TTY

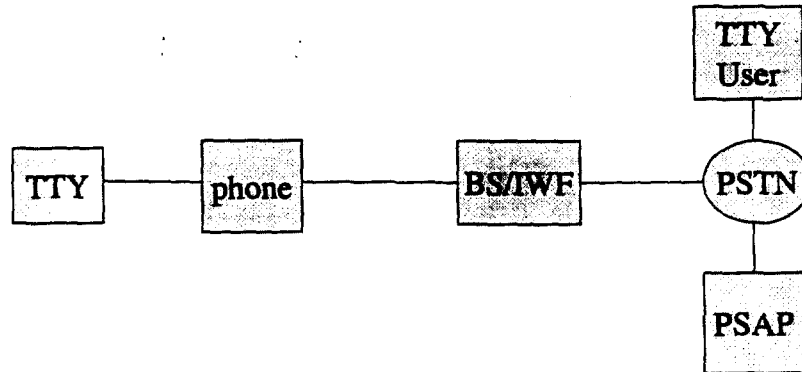
- QUALCOMM is investigating improvements and performing field tests
- Other industry members are also proposing vocoder improvements
- *But these improvements will require changes to the infrastructure, standards, and handsets*
- *Such system-wide changes can take 18-24 months to standardize and implement*

## The Data Service Solution

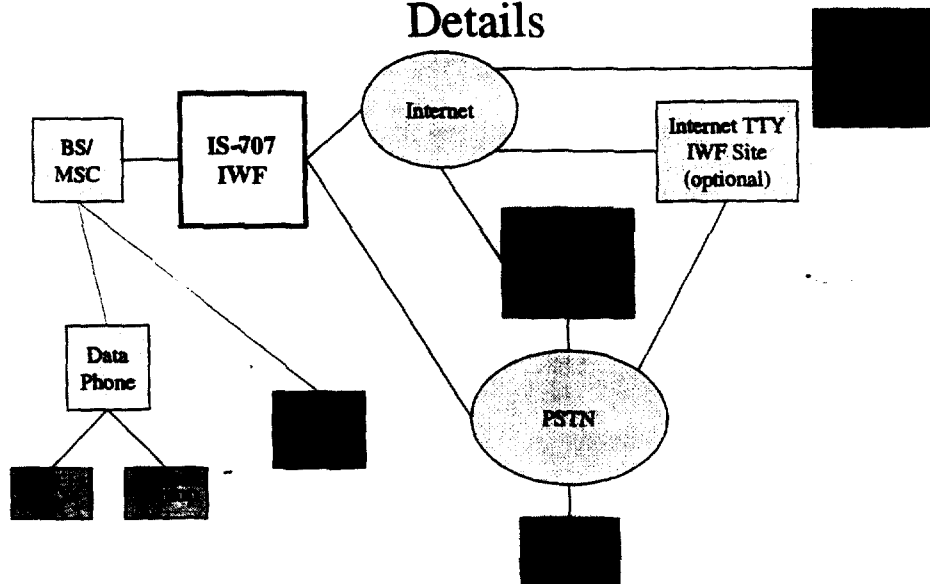
- TTY communication is inherently a data service
- CDMA data services can relay TTY data reliably (unlike voice-based services); achieves same performance as wireline TTY communication
- TTY User Community has made a formal request for data service (see Standards Request Document presented at the CTIA TTY Forum)
- CDMA data service is already standardized (IS-707) and is currently being implemented and field tested by manufacturers



## The Data Solution



## Details



## Diagram Details

- PSTN: Public Switched Telephone Network
- BS/MSC: Base Station/Mobile Switching Center
- IWF: Inter-working Function (provides TTY modem functionality to the PSTN)
- Internet TTY IWF Site (common site for TTY modem pool)
- Smart Phone - Integrated phone and digital organizer (has text display and input)

## Advantages of Data Services

- Provides very reliable TTY communication (especially important for E911 calls)
- Provides other data services for the TTY community: fax and direct access to the internet without special modems
- Allows use of advanced portable TTY solutions such as smart phones

## Advantages of Data Services (2)

- Provides data features to all users (not just TTY); carriers are already planning to deploy basic data services
- Has industry-wide market value: cost impact on carriers is significantly less than implementing a TTY-only solution based on voice services
- Already standardized as IS-707 and basic services are being implemented and field tested

## Data Solution: Challenges

- Deploy IWF's in network
  - Carriers are planning this for 1Q-3Q of '99
  - QUALCOMM is already performing field trials for basic data services with some carriers
  - QUALCOMM is conducting TTY Data testing in San Diego
- 3COM needs to upgrade software to support TTY in their IWF's
  - QUALCOMM is collaborating with 3COM on technical issues
  - 3COM needs contractual requirements from carriers

## Data Solution: Challenges (2)

- Interface between TTY device and phones (digital vs. analog interface).
  - QUALCOMM is working with TTY manufacturers on developing TTY terminals with digital interfaces
  - User community is willing to have retrofit of TTY devices
  - Possible to support analog interface but requires chipset changes in handsets

## Data Solution: Challenges (3)

- Voice-Carry-Over (VCO)
  - Major infrastructure changes to support VCO over data service (requires service switching)
- Educate users and carriers on the technical details, availability, and services
  - White papers
  - Driving the work in standards by identifying key issues (TR45.5)
  - Educating carriers and other manufacturers (CDMA Development Group and other industry fora)
  - Working with the CTIA

## Policy Considerations

- QUALCOMM and wireless industry are working hard to understand and meet TTY user needs
- Additional time is needed to complete adequate testing and to formulate intelligent strategies
- Certain features and requirements should be reconsidered given the test results and technical limitations